

REMARKS

Claims 1-6 remain pending in the application.

Reconsideration and examination of Claims 1-6 in view of the arguments below is respectfully requested.

By way of this response, Applicant has made a diligent effort to place the claims in condition for allowance. However, should there remain any outstanding issues that require adverse action, it is respectfully requested that the examiner telephone Leo J. Peters at (408) 433-4578 so that such issues may be resolved as expeditiously as possible.

RESPONSE TO THE REJECTION OF CLAIMS 1, 4 AND 5

Claims 1, 4 and 5 stand finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Doke, U.S. Patent No. 5,367,890 (Doke). Applicant traverses the rejection as follows.

Claims 1, 4 and 5 encompass a thermal profiling device for making temperature measurements of an active surface of a semiconductor die during fabrication of an integrated circuit. Specifically, Claims 1, 4 and 5 recite a packaging substrate having an upper surface, a semiconductor die having an active circuit surface secured directly to the upper surface of the packaging substrate, and a thermocouple secured directly to the active circuit surface of the semiconductor die.

The rejection errs in alleging that Doke discloses a thermal profiling device. As expressed in the abstract, Doke discloses a thermoelectric device, that is, a device for transferring heat between a cold plate (36) and a hot plate (38) by an array of thermocouples connected therebetween. The term "thermal profiling" is recognized in the art as a step

performed during the fabrication of an integrated circuit and is independent of the function of the circuit. Thermal profiling is described in the subject application as follows: "Each of these three steps (preheat, melt, and cool down) are very temperature critical requiring accurate thermal calibration of each zone. In the past, these temperatures were calibrated by a process known as thermal profiling. Thermal profiling is used to monitor a temperature vs. time curve." Because the function of thermal profiling and the function of transferring heat between a hot plate and a cold plate are not equivalent, Doke does not disclose a thermal profiling device as alleged by the rejection.

The rejection further errs in alleging that Doke discloses the claimed packaging substrate. The two electrically isolated plates (36) and (38) described in column 5, lines 35-55, between which the unidirectional current devices (14), (16), (18), and (20) are attached are not described in Doke as a packaging substrate, rather they are two separate parts of the thermoelectric system (10) that function as a sink for heat and cold. Clearly the two electrically isolated plates (36) and (38) disclosed in Doke are not equivalent to a packaging substrate as recognized in the art and as described and claimed in the present application. If the rejection is not withdrawn, Applicant requests that the rejection cite a specific column and line number where Doke teaches a packaging substrate.

The rejection further errs in alleging that Doke discloses a semiconductor die having an active surface secured directly to the upper surface of the packaging substrate. The semiconductor dies in Doke referred to by the rejection are apparently the unidirectional current devices (14), (16), (18), and (20). As explained in column 6, lines 28-33, the

unidirectional current devices (14), (16), (18), and (20) are attached to the hot plate (38) and the cold plate (36), not to a packaging substrate as described in the specification and recited in Claims 1, 4 and 5.

The rejection further errs in alleging that Doke teaches securing a thermocouple in position by forming a solder bond to a substrate. As explained above, the hot plate (36) and the cold plate (38) are not equivalent to the claimed substrate.

The rejection further errs in alleging that Doke discloses in column 5, lines 33-42 a thermocouple array secured directly to the claimed active circuit surface. Claim 1 recites a semiconductor die having an active circuit surface secured directly to the upper surface of the packaging substrate and a thermocouple secured directly to the active circuit surface of the semiconductor die. The rejection admits that Doke does not disclose securing the thermocouple directly to the claimed active surface of the semiconductor die as recited in Claim 1, and alleges that it would be obvious to modify Doke by securing the thermocouple array to the active surface of the semiconductor die.

In contrast to Claim 1, Doke explains in column 5, lines 33-42 that an array of thermocouples is placed between two thermally conductive and electrically isolated plates (36) and (38). The only semiconductor dies alluded to by the rejection in Doke are the unidirectional current devices (14), (16), (18), and (20), which are described in column 6, lines 28-33. As shown and described in Doke, the unidirectional current devices (14), (16), (18), and (20) are coupled directly to the electrically isolated plates (36) and (38) to transfer heat between them. The thermocouple array is also directly coupled to the electrically isolated plates (36) and

(38) to measure their temperature. In Doke, the temperature of the electrically isolated plates (36) and (38) is the object of the measurement, not the temperature of the semiconductor dies, i.e., the unidirectional current devices (14), (16), (18), and (20). The rejection therefore fails to establish a motivation in the prior art for modifying Doke to arrive at the claimed invention.

The rejection further errs in alleging that the two thermally conductive and electrically isolated plates (36) and (38) have an "active surface" equivalent to the claimed active surface. As defined in the specification, the claimed active surface is the interface between a semiconductor die and a packaging substrate. The rejection cites no teaching or suggestion in Doke of an active surface equivalent to an interface between a semiconductor die and a packaging substrate. Because Doke lacks the claimed active surface, the rejection fails to arrive at the claimed subject matter.

The rejection further errs in alleging that attaching a thermocouple to the active surface of a semiconductor die would be obvious to one of ordinary skill in the art. As explained in the specification beginning on page 2, line 21, Applicants have discovered that placing a thermocouple at a location other than the interface between the semiconductor die and the packaging substrate, i.e., the active circuit surface of the semiconductor die, results in temperature measurements that may vary as much as 10 degrees Centigrade from the actual interface temperature. Applicants also discovered that relying on these inaccurate temperature measurements to control the interface temperature disadvantageously results in increased chip failure rate and reduced chip reliability. Because the rejection relies on hindsight gained from Applicant's disclosure to recognize the

problem solved by the claimed securing of the thermocouple directly to the active circuit surface of the semiconductor die, and because undue experimentation on the part of one having ordinary skill in the art would be required to duplicate Applicant's discovery, attaching a thermocouple to the active surface of a semiconductor is not obvious under 35 U.S.C. § 103(a).

In summary, the rejection errs in alleging that Doke discloses the claimed thermal profiling device, the rejection errs in alleging that Doke discloses the claimed packaging substrate, the rejection errs in alleging that Doke discloses the claimed semiconductor die having an active surface secured directly to the upper surface of the packaging substrate, the rejection errs in alleging that Doke teaches securing a thermocouple in position by forming a solder bond to a substrate, the rejection errs in alleging that Doke discloses a thermocouple array secured directly to the claimed active surface, and the rejection errs in alleging that attaching a thermocouple to the active surface of a semiconductor die would be obvious to one of ordinary skill in the art. Because the rejection is based on error and not on fact, Applicant requests that the rejection be withdrawn. If the rejection is sustained, Applicant requests that the Examiner provide evidence to substantiate the rejection and to execute an affidavit in support of the alleged facts as required by 37 CFR § 1.104(d)(2) and MPEP § 2144.03.

RESPONSE TO THE REJECTION OF CLAIM 6

Claim 6 stands finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Doke and further in view of Lemoine et al., U.S. Patent No. 5,585,577 (Lemoine). Applicant traverses the rejection as follows.

Claim 6 recites a packaging substrate having a first surface and a second opposite surface, an opening passing through the second opposite surface and through the first surface of the packaging substrate, a semiconductor die having an active circuit surface secured directly to the first surface of the packaging substrate, and a thermocouple positioned inside the opening and secured directly to the active circuit surface of the semiconductor die.

There is no motivation shown in Lemoine or Doke that suggests a modification of either reference that teaches all the claimed limitations.

As explained above, the rejection errs in alleging that Doke discloses the claimed thermal profiling device, the rejection errs in alleging that Doke discloses the claimed packaging substrate, the rejection errs in alleging that Doke discloses the claimed semiconductor die having an active surface secured directly to the upper surface of the packaging substrate, the rejection errs in alleging that Doke teaches securing a thermocouple in position by forming a solder bond to a substrate, the rejection errs in alleging that Doke discloses a thermocouple array secured directly to the claimed active surface, and the rejection errs in alleging that attaching a thermocouple to the active surface of a semiconductor die would be obvious to one of ordinary skill in the art.

There is no Claim 7 pending in the subject application, therefore the rejection of Claim 7 need not be addressed. Assuming that the argument presented to support the rejection of Claim 7 is applied to the rejection of Claim 6, the rejection errs in alleging that Lemoine discloses locating a temperature sensor (32) through an opening in a substrate (10) to locate the sensor directly to a surface to

be measured. Reference numeral (10) is described by Lemoine in column 2, lines 40-42 as a housing used for supporting large bearings such as those used in steel mills. Clearly a housing for supporting large bearings is not equivalent to the claimed substrate as recognized in the art and as described and recited in Claim 6. Because the housing (10) in Lemoine is not equivalent to the claimed substrate, the rejection fails to arrive at the claimed subject matter.

The rejection further errs in alleging that "a surface to be measured" is equivalent to the claimed limitation of an active surface of a semiconductor die. Because the limitation argued in the rejection is not equivalent to the claimed active surface of a semiconductor die, the rejection fails to arrive at the claimed subject matter.

The rejection further errs in that no temperature sensor is shown or described with reference to the embodiment of FIG. 1 in which the housing (10) appears, and no housing (10) is shown or described in the embodiments of FIGS. 4 and 7 in which the temperature sensor (32) appears. Because there is no connection shown between these elements, the rejection has not established a nexus necessary to support the rejection, even if the housing (10) were equivalent to the claimed substrate.

Because neither Doke nor Lemoine teach or suggest the claimed thermocouple secured directly to the claimed active surface of the semiconductor die, and because there is no motivation in either Doke or Lemoine to modify either reference to arrive at the claimed invention, Claim 6 is not obvious under 35 U.S.C. § 103(a).

RESPONSE TO THE REJECTION OF CLAIMS 2 AND 3

Claims 2 and 3 stand finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Doke as applied to Claim 1 and further in view of Hayes, U.S. Patent No. 5,681,757 (Hayes). Applicant traverses the rejection as follows.

Claims 2 and 3 recite materials for securing the claimed thermocouple directly to the claimed active circuit surface of the semiconductor die.

As explained above with regard to Claims 1, 4 and 5, the rejection errs in alleging that Doke discloses the claimed thermal profiling device, the rejection errs in alleging that Doke discloses the claimed packaging substrate, the rejection errs in alleging that Doke discloses the claimed semiconductor die having an active surface secured directly to the upper surface of the packaging substrate, the rejection errs in alleging that Doke teaches securing a thermocouple in position by forming a solder bond to a substrate, the rejection errs in alleging that Doke discloses a thermocouple array secured directly to the claimed active surface, and the rejection errs in alleging that attaching a thermocouple to the active surface of a semiconductor die would be obvious to one of ordinary skill in the art. Because the rejection is based on error and not on fact, Applicant requests that the rejection be withdrawn.

Hayes is directed to dispensing adhesive, and does not teach or suggest the claimed thermocouple, therefore there is no motivation in Hayes to modify Doke to arrive at Claims 2 and 3.

Because neither Doke nor Hayes teach or suggest the claimed thermocouple secured directly to an active surface of the semiconductor die, and because there is no motivation in

Amendment page 10 of 10
09/465,131

DOCKET NO. 99-099
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either Doke or Hayes to modify Doke to arrive at Claims 2 and 3, Claims 2 and 3 are not obvious under 35 U.S.C. § 103(a).

Conclusion

In summary, the rejection of Claims 1-6 is unsubstantiated, therefore the PTO has not met its burden under 35 U.S.C. § 103(a). If the rejection is sustained, Applicant requests that the Examiner provide evidence to substantiate the rejection and to execute an affidavit in support of the alleged facts as required by 37 CFR § 1.104(d) (2) and MPEP § 2144.03.

No additional fee is required for this amendment.

In view of the above, Applicant submits that Claims 1-6 are in condition for allowance, and prompt and favorable action is earnestly solicited.

Respectfully submitted,



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